Section A: Why does an apple turn brown when peeled?
When an apple is cut, oxygen comes in contact with the fruit’s inner tissue and browning occurs. One particular enzyme in the apple cells, polyphenol oxidase, begins breaking down the tissue. This process may be the plant’s way of keeping pests away from a cut or broken area. What could you do to stop this browning action?

Section B: Enzyme Activity Webquest
Click on “Websites-Cells” page, then select “Enzyme Activity”. Go through the animation and answer these questions.
1. Enzymes are ____________________ that help to ____________________ chemical reactions in the body.
2. Why are enzymes necessary? ____________________
3. Enzymes are specific. What does that mean? ____________________
4. Enzymes are not changed during a reaction. What does that mean? ____________________
5. Why is the shape of an enzyme important? ____________________
6. What factors can denature an enzyme? ____________________
7. When a protein denatures, what happens to the enzyme? ____________________
8. Click on “Why Enzymes?” and play the animations. How is the reaction different without an enzyme and with an enzyme? ____________________
9. Click on “Enzyme Menu”, then click on “Specificness”. Play the animation and explain what is occurring? ____________________
10. Click on “Enzyme Menu”, then click on “Reusing Enzymes”. Play the animation and explain what is occurring. ____________________
11. Click on “Enzyme Menu”, then click on “Denaturing”. Play the animation and explain what is occurring. ____________________

Section C: Enzyme Questions
1. Reactants in an enzyme catalyzed reaction are called ____________________.
2. Which type of macromolecule are enzymes categorized as? ____________________
3. Identify if the following statements are True or False.
   a. _______ Enzymes are used up during a chemical reaction.
   b. _______ Enzymes speed up reactions.
   c. _______ One enzyme can be used for many different types of reactions.
   d. _______ Enzymes interact with specific substrates.
   e. _______ Enzymes change shape after a chemical reaction.
   f. _______ Enzymes decrease the activation energy.
   g. _______ Enzymes can function inside and outside of cells.
   h. _______ All enzymes are proteins.
4. Enzymes unwind or __________________ when placed in extreme pH or temperature conditions.

5. Identify the parts of the diagram.

   ![Diagram]

   _____ Products  
   _____ Substrate 
   _____ Active Site  
   _____ Enzyme-Substrate Complex  
   _____ Enzyme

6. Identify if the following external factors will increase, decrease or not change the rate of chemical reaction.
   a. Raising the temperature slightly. _______________________
   b. Adding more substrate. _______________________
   c. Changing the pH away from the optimal pH. _______________________
   d. Boiling temperatures. _______________________
   e. Adding an inhibitor. _______________________

7. How does changing an enzyme shape cause it to work poorly or not at all? ________________

8. Explain what is occurring in the graph.
   a. Between A and B
      ______________________
      ______________________
      ______________________
   b. Between B and C
      ______________________
      ______________________
      ______________________
      ______________________
      ______________________

Section D: Enzyme Inhibitors
Watch the video “Enzyme Function & Inhibition”. Explain how the non-competitor inhibitor and the competitive inhibitor affect an enzyme. ________________________________

   ________________________________
   ________________________________
   ________________________________
   ________________________________

   ➤ If you need more information on inhibitors, click on “Websites-Cells” page, then select “Enzyme Animation”. Go through the animation “Enzyme Inhibitors”.

Section E: Enzyme Denaturation
Click on “Websites-Cells” page, then select “Enzyme Denaturation”. Watch the video and explain what happens to an enzyme when it’s denatured. ________________________________

   ________________________________
   ________________________________

   ➤ Another video on Protein Denaturation….. https://www.youtube.com/watch?v=SUCgAxI8rhg
**Section F: Enzyme Lab**

What would happen to your cells if they made a poisonous chemical? You might think they would die, but cells use enzymes to break down these poisonous chemicals into harmless substances. The enzyme Catalase is a common enzyme found in nearly all living organisms. It accelerates the decomposition of hydrogen peroxide $\text{H}_2\text{O}_2$. One molecule of catalase can break 40 million molecules of hydrogen peroxide each second.

$$2\text{H}_2\text{O}_2 + \text{Catalase} \rightarrow 2\text{H}_2\text{O} + \text{O}_2$$

**Lab 1: Enzyme Activity**

1. Add a small piece of room temperature potato into a clean test tube. Place 2 mL of hydrogen peroxide into the test tube. Observe the bubbles; what gas is being released?

2. Record the bubble observation. Assume that this reaction is a “4” on the scale.

**Lab 2: Temperature**

1. Obtain a small piece of potato that has been in the freezer and place it in a clean test tube. Add 2 mL of hydrogen peroxide into the test tube. Observe the bubbles and record your observation.

2. Obtain a small piece of potato that has been boiled and place it in a clean test tube. Add 2 mL of hydrogen peroxide into the test tube. Observe the bubbles and record your observation.

**Lab 3: pH**

1. Obtain a small piece of potato that has been soaking in acid and place it in a clean test tube. Add 2 mL of hydrogen peroxide into the test tube. Observe the bubbles and record your observation.

**CAUTION----Use forceps to remove the potato. DO NOT get the acid on your skin.**

<table>
<thead>
<tr>
<th>LABS</th>
<th>Rate of Reaction…..how rapidly the solution bubbles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab 1 – Potato at room temperature</td>
<td>Scale from 0-5 (0=slow reaction &amp; 5=fast reaction)</td>
</tr>
<tr>
<td>Lab 2 – Potato from freezer</td>
<td></td>
</tr>
<tr>
<td>Lab 2 – Boiled Potato</td>
<td></td>
</tr>
<tr>
<td>Lab 3 – Potato in Acid</td>
<td></td>
</tr>
</tbody>
</table>

**Post Lab Questions:**

1. What does rate of reaction indicate? __________________________________________

2. Some of these external factors denatured the catalase enzyme. What does denature mean? 

3. Identify these parts of the enzyme-substrate complex.
   
   Substrate = _____________________ Products = ______________

4. In the room temperature potato, if you poured off the liquid into a second test tube. Assuming the reaction is complete and all the hydrogen peroxide has been broken down by the catalase.
   
   a. What should the liquid be composed of? ____________________________

   b. Based on your above response, what do you think would happen if you added more potato to this liquid?

   c. If you take the used potato from the initial reaction and added 2 mL of hydrogen peroxide, would a reaction occur? Why or why not? ________________________________________________

**To see the Catalase virtual lab: Click on “Websites-Cell”, then on “Enzyme Catalase Lab”**
Section G: Concept Check

Match the following words with their definitions.

1. Product _____
2. Active site _____
3. Enzymes _____
4. Catalyst _____
5. Substrate _____
6. Activation energy _____

7. Like all proteins, enzymes are denatured by extremes of pH. Each enzyme has a preferred pH range for optimum activity.
   a. State the optimum pH for each enzyme.
      Pepsin _____  Trypsin _____
   b. Pepsin breaks down proteins in the stomach and requires an acidic environment to work. How would pepsin activity be affected if it were put in a neutral solution? __________________________________________

8. Explain how extreme temperatures and pH denature an enzyme.
   ___________________________________________________________________________
   ___________________________________________________________________________
   ___________________________________________________________________________

9. Identify the following in the diagram.

   Enzyme _______
   Substrate _______
   Products _______

10. At high temperatures, the rate of enzyme action decreases because the increased heat ___.
    a. changes the pH of the system
    b. alters the active site of the enzyme
    c. neutralizes the acids and bases in the system
    d. increase the activation energy

11. An enzyme that hydrolyzes starch will not act upon proteins. This fact is an indication that enzymes are _____________.

**Practice quiz on Enzymes**
http://www.edhsgreensea.net/Biology/taters/enzyme_mc.htm
http://www.sciencegeek.net/Biology/review/U2Enzymes.htm
http://highered.mheducation.com/sites/007337797x/student_view0/chapter6/animation_quiz_-_how_enzymes_work.html